DESIGN AND ECONOMIC ANALYSIS OF SOLAR HOME SYSTEM FOR URBAN AREAS OF MOGADISHU USING HOMER SOFTWARE

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To my beloved family

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ABSTRACT

In this century of enhanced progress by various spaces, some African states are still challenging lack of energy due to scarcity in some places. The most used energy (generation of electricity) is hydropower because heat and fuel are still on some scale. This problem comes about in less efficiency and financial decay of some nations such as Somalia which is among the country at very high speed in progress, the grid lines from distant places are stack and they are rare matched to the required of power in all areas of the nation, especially in remote or urban areas where each household needs electricity utilization instead of utilizing local, conventional and lighting at domestic. This issue can be illuminated utilizing other elective sources of renewable energy for provincial electrification such as Photovoltaic systems. Hence, this project basically focuses on the design of SHS that incorporate financial assessment and utilize of an individual SHS of 200W, so that the satisfaction of the people and the targets of the country can be effectively achieved. Under this project, the dedicated on the investigation of power utilization based on single house household family SHS has been taking a case study of one village in Mogadishu Somalia named Heliwaa placed in Benaadir region. The survey was conducted by assessing the average major load conditions for consecutive hours per day based on photovoltaic capacity. The purpose of this study was achieved the optimal size of the photovoltaic panel and the battery capacity that can be used to power the home. Ultimately, designed project and cost will be compared to other private sector electricity cost, it means which one is more reliable and economically for electricity generation. Therefore according to, the findings the cost of energy is 2.614 in $/KWh which is lower than the private sector. This was considered optimum solution. In this project the design and simulation tasks was achieved through the assistance of HOMER software. The electrification and economics information on combination of photovoltaic systems, in the form of SHS and other renewable energy like stand-alone systems, to provide a reliable and economic system.

ABSTRAK

Pada kurun ini, kemajuan dalam mempertingkatkan penggunaan pelbagai ruang di sesebuah kawasan Afrika adalah masih dalam situasi mencabar dari segi kekurangan tenaga kerana sukar untuk didapati pada sebahagian tempat, dimana menggunakan sumber utama tenaga (penjanaan elektrik) iaitu hidro kerana haba dan bahan bakar masih terdapat pada skala kecil. Masalah ini menggundang kecekapan rendah dan penyusutan kewangan pada kawasan seperti Somalia, dimana ia adalah diantara negara yg pesat dari segi kemajuan, garis rangkaian pada kawasan pedalaman adalah tertumpu dan sukar dipadankan dengan keperluan tenaga seluruh kawasan negara ini terutama di kawasan terpencil dan zon pedalaman dimana setiap isi rumah memerlukan daya guna tenaga bukannya daya guna tempatan, konvensional, dan lampu domestik. Isu ini boleh diiluminasi menggunakan sumber elektif lain dari tenaga boleh pulih untuk wilayah elektrifikasi seperti Sistem Fotovoltan. Justeru, projek Sarjana ini asasnya fokus kepada reka bentuk SH menggabungkan penilaian kewangan dan daya guna perseorangan SHS 200 W, supaya kepuasan pengguna dan kumpulan sasar negara itu memberi kesan tercapai. Di bawah projek Sarjana ini, diberi fokus kepada penyelidikan tentang daya guna tenaga berdasarkan pemilikan perseorangan sesebuah rumah SHS yang telah diambil kajian kes pada sebuah perkampungan di Mogadishu, Somalia yang bernama Heliwaa terletak di sekitar sektor Banadir. Kajian ini telah dilakukan penilaian secara menyeluruh tentang profil purata beban primer pada nombor berturutan iaitu jam setiap hari bergantung pada keupayaan penjanaan PV. Objektif kajian ini adalah untuk mencapai tahap pensaizan optimal panel PV dan keupayaan bateri yang digunakan untuk membekal keelektrikan kepada isi rumah. Akhirnya, reka bentuk projek dan kos akan dibandingkan dengan sektor swasta yang lain, yang mana lebih kebolehpercayaan dan ekonomi untuk penjanaan keelektrikan.
Oleh itu menurut, penemuan kos tenaga ialah 2.614 dalam $/KWh yang lebih rendah daripada sektor swasta. Dalam projek ini, reka bentuk dan tugas simulasi telah tercapai melalui bantuan perisian HOMER. Elektrifikasi dan bahan informasi ekonomi tentang

kombinasi sistem fotovoltan, pada bentuk SHS dan lain-lain sumber boleh pulih seperti sistem sedia ada untuk menyumbang kebolehpercayaan dan sistem ekonomi.

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AC	-	Alternating Current
AH	-	Ampere Hour
BC	-	Battery Capacity
BECO	-	Banadir Electricity Company
BOS	-	Balance Of System
C	-	Cost
C rate	-	Rate of Charge or Discharge
CE	-	Cost Estimation
Cm^2	-	Centimeter Square
COE	-	Cost of Energy
CS	-	Cost Summary
d	-	is the nominal interst rate (%)
DC	-	Direct Current
DOD	-	Depth of Discharge
DVD	-	Digital Versatile Disc
H	-	Hargeisa
HOMER	-	Hybrid Optimization Model for Electric Renewables
i'	-	is the annual inflation rate (%)
IV	-	Current Voltage
K	-	Kismayo
KW	-	Kilo Watt
Kw/M^2	-	Kilo watt Per Meter Square
KWh	-	Kilo Watt Hours
Kwh/d	-	Kilo watt Hours Per Day
LCOE	-	Levelized Cost of Energy
M	-	Mogadishu
M/S	-	Meter Per Second

MW	-	Mega Watts
N/A	-	Not Available
NA	-	Number of Photovoltaic Array
NASA	-	National Aeronautics and Space Administration
NPC	-	Net Present Cost
NPV	-	Net present Value
NREL	-	National Renewable Energy Laboratory
O&M	-	Operating and Maintenance
PG	-	Power Generation
PVGIS	-	Photovoltaic Geographical Information System
PV-SYST	-	Photovoltaic System
P_{year}	-	Profit Earned Every Year
PV	-	Photovoltaic
RE	-	Renewable Energy
S_{scr}	-	Solar Charger Controller
SHS	-	Solar Home System
SMEs	-	Small Medium Enterprises
$T_{payback}$	-	Total of Payback
TV	-	Television
UN	-	United Nation
USD	-	United States Dollar
V_T	-	Terminal Voltage
V_T	-	Terminal Voltage

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CHAPTER 1

INTRODUCTION

1.1 Background of the Project

Renewable energy is becoming more attractive, especially as oil prices fluctuate. Solar energy has good potential and direct conversion technology. There are several positive attributes based on solar Photovoltaic, especially in remote areas [1]**.** A Photovoltaic (PV) system considered one of the crucial alternative sources. Because PV energy production is clean, freely infinitely available and of high reliability, it is a very attractive power source for many applications, especially in rural and remote areas in East Africa where they have a large quantity of solar radiation around the year.

Somalia has been blessed with a lot of solar energy. The varying amount of generating power and the scope of thermal applications using solar energy is huge. The accuracy of renewable sources depends on the environmental location and climatic condition of the area, accessible resources and the economics of the power system [2]. Somalia is ideally placed to utilize solar energy; the daily sunshine of Somalia almost becomes 10 hours. Furthermore, the temperature is not so high with yearly average of 30 °C that in turn adds to the operational life of solar PV's. Somalia it is questionable that the key grid connection did not be established. A stand-alone PV system with storage battery will be excellent choice for Somalia.

The photovoltaic (PV) cell converts sunlight into electricity. PV or solar cells are the basic component of the PV system. PV cells form a larger unit called components that are connected to each other and can be associated in an array of excellent part name arrays. These arrays are connected in parallel and in series to meet basic power requirements. Since the photovoltaic array is only illuminated once to generate electricity, an excellent energy storage mechanism is typically implemented,

the most common being a series of rechargeable batteries. In order to avoid overcharging and over discharging of hazardous batteries and to drive AC loads, charging controllers and converters must be implemented.

The PV array of stand-alone photovoltaic systems, the size of the inverter and the battery are an important part of the system design. In this section, solar radiation data is required for the intended location of the installation site, load requirements, photovoltaic modules, inverters, batteries and their operational efficiencies. Finally, mark the behavior of many students and easily advance the sizing method. Applicable and reliable [3].

In these greatest methods assumed endless system load and control the variables that have guidance on the degree of dependability. Approaches that are constructed on the theory of power supply through a quantity of autonomous days are classically used. These methods are simple and guarantee the mandatory dependability of the PV system through autonomous days. In-these methods, the storage system run into the load demand. The storage system capacity is considered as a quantity of dependability of the PV system. So, the dependability is strong-minded by the autonomous days. These methods exhibit no direct association flanked by the PV array production and the storage-system-capacity [4]. Also, the resultant sizing of the arrangement of PV array and battery bank for a solar PV system is not necessarily optimal.

To improve the consumption of the renewable energy bases professionally and economically, best conformation project sizing method is required, the sizing of stand-alone PV system is significant in the system project that quiet is an active area of study [5]. Sizing optimization method be able to assistance decreasing the invest cost for installing PV system lack of surrendering in the constancy of PV system. Lack of the system sizing procedure, the scheme project may over size, that is outcome in expensive project [6]. Outstanding to the accidental environment of the energy-source, an unlimited struggle is necessity has been completed to enhance the scheme of stand-alone PV systems in terms of both energy feeding and budgets. The budget of the renewable energy generation plays the main part in decisive the efficiency of the PV systems.

1.2 Problem Statements

Due to the shortage in the fossil fuels as well as the continuous increase in the fuel prices in recent years, there has been a demand to using non-traditional energy sources such as renewable energy. Also, needs to minimize the global air pollution and to control the climate changes should be encourage the dependence of renewable energy sources. Solar energy can be considered one of the most important and reliable energy sources to cover the limited availability of the traditional energy sources.

Electrical power access plays the vital role in hastening cost-effective progress by humanizing healthiness as well life cycle principles. Important investiture has been completed in energy sector to advance power entrance in homes also other struggle required to be completed by Banadir resident engineers in partnership with private sectors to meet the sets goals of electrifying of households.

For the beyond goals to be accomplished, a combination-of several results that focus on the geographical location, revenue and consumption level is required as a replacement of consuming the traditional connection to the network which is not appropriate in place of urban and remote homes. Off grid PV system may considered a sustainable solution that can be implemented by simple SHS generation of technologies that produce electricity power by the primary equipment's of the house to stand-alone systems which can produce high levels of electricity that can be used in homes and other commercial centers.

This method can assist as cost-effective and dependable result for growing the rare of power admittance by the entire urban and remote municipal and nation via overall. By gratitude of the above proposed solutions, the study took as well confirmed which the long-term annual average global irradiation in various regions is directly above 1700kWh/m^2. This shows how many sites of Somalia are favourable applicants for applications of PV solar systems.

In this regards, the SHS in Mogadishu province, Hodan, Kahda, and Heliwaa district, specifically in small demand areas, can bring predictable helpful payback for the families and community service area as numerous rural communities in this location populations they have not right of entry for country and private sector electric network line at all. These shortage availabilities is affected through high cost of transmission line and high cost of electricity for every kW which is nearby $1.5 for low voltage and $1 for medium voltage. So, the nominated area is parched by great

concentration of sun radiations, these varieties the place more attractive for the use of Photovoltaic system of power generation and storage.

1.3 Objectives of the Project

The main purpose of this master project is to show how to address and solve the solar power system to address energy access issues in Somalia. The civil society in this areas such as Heliwaa district in Banadir region. After that, the high cost of transmission lines, due to the high cost per 1kW of power from the private sector is not readily available in the village. From the perspective of cost and efficiency point of view, it has been proposed SHS and other photovoltaic technology. Application of the climatic conditions of the facility, Banadir section will accept abundant amount of sunlight in the daytime. Since solar energy is not only available during the day, it is important to use with the energy supply system, which is similar to the supply from the battery to the load. These methods compensate for electricity demand thus causative to the sustainable progress, which will contribute to the growth of cost-effective countries. The next goal should be adept at understanding the intended objectives of the project.

i. To design a Stand-alone solar PV system based on averaged consumption home.
ii. To simulate the PV system design for home by using HOMER Software®.
iii. To evaluate the cost of stand-alone PV home system in Mogadishu by HOMER software.

1.4 Scope of the Project

The master project's scope of work is limited to the purpose of optimum photovoltaic system in urban and remote areas of power generation inattentive. In addition, consider the following constraints to complete the system interprets assessment.

i. Significant data on radiation at designated locations comes from Africa's photovoltaic geographic information system, which is useful for providing solar energy resources. It was used in the design and simulation of photovoltaic power generation systems in Mogadishu to estimate the budget of the stand-alone photovoltaic system.

ii. Assuming annual solar energy input and main load curve to continue endless through the project lifetime. This project lifetime was considered recognised as solar panels are guaranteed around 25 years.

iii. The case study for the project is Mogadishu Somalia and Somali regions as well. This project study is limited for design and economic analysis of solar home system (SHS) in Mogadishu. In this project will be used Hybrid Optimization model for Electric Renewables (HOMER) software®.

1.5 Research Motivation

Renewables are a particularly profitable option for the country given their abundance, the increasing affordability of renewable products, and the fact that a market for renewable energy has already been established in the country. Mainly, hybrid systems are divided into two categories as stand-alone and grid connected systems. Stand-alone systems are the most promising technologies for supplying load in remote and rural areas. They provide greater dependability, advanced efficacy and lower cost in comparison with using single resources technologies. Since the combination of PV and wind are the most common sources of renewable energies in stand-alone systems, in this study of optimization of stand-alone systems which include photovoltaic (PV) as the sources of energy generations combined with battery will be investigated.

1.6 Report Outline

This project report consists of five main parts:

(a) Chapter 1: Introduction

This chapter explains-introduction of the project. It also explains the background of the project. This is also developing HOMER software® based solar home system with details information. Also, problem statement, project objectives, scope of work, research motivation and report outline.

(b) Chapter 2: Literature Review

This chapter fundamentally evaluations and discusses earlier study and outcome for this area and how it concern to this effort. This also determines some improvement commencing former effort to combine the objective of this project.

(c) Chapter 3: Methodology

This chapter describes the methodology of the project. The design and methods use are explained in this chapter and rising solar home system in HOMER software®. Also includes system components, site meteorological data, load analysis, cost estimation of different components also follows working procedure and finally sizing of PV modules based on the current load profile also battery sizing referred to given capacity power, moreover single line diagram theory about solar home system and overview for simulation software used in this project.

(d) Chapter 4: Result Analysis and Discussion

This chapter focuses on result analysis and discussion based on optimization and sensitivity analysis also follows some discusses about simulation results obtained for achieving the least cost feasible options.

(e) Chapter 5: Conclusion and Recommendation

This chapter Specific conclusion are made on basis of the analysis and project outcome. At the end recommendations and future work has been suggested.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter focuses on previous work to gathering further design stand-alone of photovoltaic systems, as well as ways to complement the optimization and reliability of photovoltaic systems. This chapter also includes modeling the components used in the HOMER software and other software to understand the performance of each paper related to the domestic solar system.

2.2 Solar Home System

The sun is a renewable source of clean energy and that is a gradually more valued advantage. Solar photovoltaic systems produce power lack emissions of air polluting gases, greenhouse gases and constituent part that are by products of combustion fuels. The source of fuel for solar PV system sunlight and solar heat is endless and free. That does not mean the electricity is free, on the other hand can be with the exception of currency. By the current progresses in solar PV technologies, the budget of solar power remains to precipitation also procedure be situated a growth. As solar PV system are long lasting and necessitate little conservation, the budget of generating power remains comparatively constant and expectable over a long-time. Owning a SHS can be assurance compared to energy price proliferations that affect other power sources.

SHS are stand-alone PV systems that offer a cost-effective mode of supplying facility power for lighting and applications to remote off-grid homes. In urban and remote zones that are not associated to the network, solar home system can be used to

meet a domestic's power demand satisfying elementary electrical requirements. Worldwide solar home system arranges for electrical to hundreds of thousands of houses in rural sites everyplace electrifications by the network is not possible. The solar home system generally work at a ranked voltage of 12 V direct current (DC) and afford electrical for low power DC appliances such as lights, radios, Mobile, freezer also small television for about four to six hours a day [7].

2.3 Electricity Generation and Consumption in Somalia

Solar photovoltaic power systems are best suited all over Somalia because major cities of Somalia can get Average irradiance equally to 5.7 kWh/m^2/day. Most parts of Somalia enjoy bright sunshine throughout the year it gets approximately 300 days of sunshine per year. With over 3000 hours of high and constant sunlight annually, it means that solar system is suitable all Somalia region.

Referred to appendix D, the generation and electricity consumption in Somalia has increased in recent years; this trend can be attributed to an increase in the population and to the search for fun. In 2015, the capacity of the electric generator installed in Somalia is 80 megawatts (MW). The Net electricity generated in 2018 is 0.31 billion kilowatt hours. In 2014, electricity consumption was 0.29 billion kilowatt hours. The main source of electricity production comes from petroleum products imported from abroad. Because of the expensive and unreliable nature of electricity in Somalia, people have resorted to the most economical and reliable source of energy that is firewood or coal. It seems that generation and consumption in Somalia will increase from year to year [8].

Referred to appendix D, shows that the production and use of electricity in Somalia is expanding in recent years. This pattern contributes to population growth and quest for pleasure. Figure 2.1 shows the electricity consumption in the country. It can be assumed that consumption of electricity it was slightly increased from 2000 up to 2018 year by year consumption. Power is essentially produced through the burning of fossils fuel.

REFERENCES

[1] Hussain S M S, Tak A, Ustun T S and Ali I 2018 Communication Modeling of Solar Home System and Smart Meter in Smart Grids *IEEE Access* 6 16985–96

[2] Benti N E 2017 Combining Wind and Solar Energy to Meet Demands in Somali Region of Ethiopia (A Case of Dembel District) *Am. J. Mod. Energy* 3 73–83

[3] Bouzid Z, Ghellai N and Benmedjahed M 2015 Estimation of Solar Radiation, Management of Energy Flow and Development of a New Approach for the Optimization of the Sizing of Photovoltaic System; Application to Algeria *Int. J. Renew. Energy Res.* 5 317–24

[4] Perea-Moreno A J, Hernandez-Escobedo Q, Garrido J and Verdugo-Diaz J D 2018 Stand-alone photovoltaic system assessment in warmer urban areas in Mexico *Energies* 11 1–13

[5] Bataineh K and Dalalah D 2012 Optimal Configuration for Design of Stand-Alone PV System *Smart Grid Renew. Energy* 03 139–47

[6] Semaoui S, Hadj Arab A, Bacha S and Azoui B 2013 Optimal sizing of a stand-alone photovoltaic system with energy management in isolated areas *Energy Procedia* 36 358–68

[7] Syahputra R and Soesanti I 2017 Solar Home System Application in Batik Industry 12 5995–6001

[8] Sheikh M S 2016 *BECO Powering Somalia*

[9] BMU 2011 Renewable Energy Sources in Figures 116p.

[10] Abdilahi A M, Mohd Yatim A H, Mustafa M W, Khalaf O T, Shumran A F and Mohamed Nor F 2014 Feasibility study of renewable energy-based microgrid system in Somaliland's urban centers *Renew. Sustain. Energy Rev.* 40 1048–59

[11] Federal Government of Somalia 2015 Somalia's *intended nationally*

determined contributions (indcs) 1–8

[12] Anon 1988 Somalia renewable energy sources in somalia

[13] Soediono B 1989 Photovoltaic (PV) materials and devices *J. Chem. Inf. Model.* 53 160

[14] Anon 2012 Investigation of electronic and structural properties of silicon solar cell contacts

[15] Varma B R K and Naik M G 2016 Simulation And Analysis Of Stand Alone Pv System With Single Phase And Three Phase Loads 1584–92

[16] Deepak M. Patil S R M 2016 Design and Development of Solar Tree for Domestic Applications *Int. J. Eng. Sci. Res. Technol.* 5 102–11

[17] Faisal S M A Model of Grid Connected Photovoltaic System Using MATLAB / SIMULINK 1–12

[18] Liu J and Hou R 2014 Solar Cell Simulation Model for Photovoltaic Power Generation System 4

[19] Eltawil M A and Zhao Z 2010 Grid-connected photovoltaic power systems: Technical and potential problems-A review *Renew. Sustain. Energy Rev.* 14 112–29

[20] Baghdadi F, Mohammedi K, Diaf S and Behar O 2015 Feasibility study and energy conversion analysis of stand-alone hybrid renewable energy system *Energy Convers. Manag.* 105 471–9

[21] Hans S and Beyer G 2015 Analysis of Power System Options for Rural Electrification in Rwanda Odax Ugirimbabazi

[22] Ş D P, Ş C F Ă R C A and Ciocan I 2008 Modelling and simulation of photovoltaic cells *Model. Meas. Control A* 49 42–7

[23] Metwally A E 2005 Modelling and Simulation of a Photovoltaic Fuel Cell Hybrid System. PhD Thesis 166

[24] Hansen A D, Sørensen P and Hansen L H 2000 *Models for a Stand-Alone PV System* vol 1219

[25] Arif M T, Oo A M T and Ali A B M S 2013 Estimation of Energy Storage and Its Feasibility Analysis

[26] Jafar Saif Edden Abdel Hafeath Jallad 2012 Faculty of Graduate Studies Design and Simulation of a Photovoltaic System with Maximum Power Control to Supply a Load with Alternating Current By

[27] O f E 2017 Centralized and Decentralized Solar Power Control and

Distribution : A comparative analysis of operational and economic aspects

[28] Bureau S 2016 Recommended citation : NREL (National Renewable Energy Laboratory). 2016 . 2016 Annual Technology Baseline . Golden , CO : National Renewable Energy Laboratory .

[29] Shenawy E T El, Hegazy A H and Abdellatef M 2017 Design and Optimization of Stand-alone PV System for Egyptian Rural Communities 12 10433–46

[30] Bhattacharyya S C 2017 Renewable Energy-Based Mini-Grid for Rural Electrification : Case Study of an Indian Village

[31] Kaabeche A, Belhamel M and Ibtiouen R 2010 Optimal sizing method for stand-alone hybrid PV / wind power generation system *Rev. des Energies Renouvelables SMEE'10 Bou Ismail Tipaza* 205–13

[32] February J Economic Analysis of a Stand-Alone Residential Solar PV System for a Typical South African Middle Income Household

[33] Salam M A, Aziz A, Alwaeli A H A and Kazem H A 2013 Optimal sizing of photovoltaic systems using HOMER for Sohar, Oman *Int. J. Renew. Energy Res.* 3 301–7

[34] Al-Hamdani A H, Dawood A F, Abdullah K N and Mousaui S M 2016 Optimal sizing of photovoltaic systems using HOMER for Baghdad *Int. J. Comput. Appl. Sci.* 1 1–6

[35] Ahsan S, Javed K and Rana A S 2016 Design and cost analysis of 1 kW photovoltaic system based on actual performance in Indian scenario ☪ *Perspect. Sci.* 8 642–4

[36] ARC 2018 Situation in South and Central Somalia (including Mogadishu) 2018 1–492

[37] Anon Somalia Energy Sector Needs Assessment and Investment Programme. November PDF.pdf

[38] Bellia H 2014 A detailed modeling of photovoltaic module using MATLAB *NRIAG J. Astron. Geophys.* 3 53–61

[39] Design C and Laroussi I 2017 *School Of Science And Engineering Cost Study And Analysis Of Pv Installation Per Watt Capacity In Ifrane*

[40] Prof A, Carlos J and Menezes R De 2016 *Payback Period Analysis Of Using Green Energy Within The Scope Of Smart Urban Regeneration And Selection Of Green Vehicles In Turkey* Baturay Yenilmez Master of Science in Business

Administration Supervisor :

[41] wholesalesolar.com 1 kW Grid-Tied Solar System with 4x Astronergy 260W Panels - Wholesale Solar

[42] Robson P and Bonomi D 2018 Growing The Battery Storage Market 2018: Exploring four key issues *Energy Storage World Forum*

[43] Gangwar S, Bhanja D and Biswas A 2015 Cost , reliability , and sensitivity of a stand-alone hybrid renewable energy system — A case study on a lecture building with low load factor

[44] World T, Group B, Official F O R, Only U S E and No R 2018 Public Disclosure Authorized A Document of The World Bank Group Federal Republic Of Somalia